Kepler's Laws

① $$\frac{T_v^2}{r_v^3} = \frac{T_e^2}{r_e^2}$$

$$\frac{T_v^2}{(1.1\times10^{11})^3} = \frac{365^2}{(1.49\times10^{11})^3}$$

$$T_v = \sqrt{\frac{365^2\,(1.1\times10^{11})^3}{(1.49\times10^{11})^3}}$$

$$T_v = \boxed{231.5 \text{ days}}$$

② $$\frac{r_m^3}{T_m^2} = \frac{r_e^3}{T_e^2}$$

$$\frac{r_m^3}{(689.98)^2} = \frac{(1.49\times10^{11})^3}{(365)^2}$$

$$r_m = \sqrt[3]{\frac{(689.98)^2\,(1.49\times10^{11})^3}{(365)^2}}$$

$$r_m = \boxed{2.28\times10^{11}\text{ m}}$$

(3) $\frac{T^2}{r^3} = \frac{T_e^2}{r_e^3}$

$\frac{T^2}{(2\times10^{11})^3} = \frac{365^2}{(1.49\times10^{11})^3}$

$T = \sqrt{\frac{365^2 (2\times10^{11})^3}{(1.49\times10^{11})^3}}$

$T = \boxed{567.6 \text{ days}}$

(4) $\frac{r^3}{T^2} = \frac{r_e^3}{T_e^2}$

$\frac{r^3}{(2\text{yr})^2} = \frac{(1\text{ AU})^3}{(1\text{ yr})^2}$

$r^3 = \frac{1^3 \cdot 2^2}{1^2}$

$r^3 = 4$

$r = 1.59 \text{ AU}$

The planet is $\boxed{1.59}$ times further from the sun.

⑤ Moon

$$K = \frac{T^2}{r^3} = \frac{(2.36 \times 10^6)^2}{(3.8 \times 10^8)^3} = \boxed{1.0 \times 10^{-13} \ s^2/m^3}$$

⑥ Earth

$$K = \frac{T^2}{r^3} = \frac{(27.322)^2}{(384.4 \times 10^3)^3} = \boxed{1.3 \times 10^{-14} \ d^2/Km^3}$$

Mars

$$K = \frac{T^2}{r^3} = \frac{(0.319)^2}{(9.38 \times 10^3)^3} = \boxed{1.2 \times 10^{-13} \ d^2/Km^3}$$

Jupiter

$$K = \frac{T^2}{r^3} = \frac{(0.675)^2}{(221.9 \times 10^3)^3} = \boxed{4.2 \times 10^{-17} \ d^2/Km^3}$$

Saturn

$$K = \frac{T^2}{r^3} = \frac{(0.695)^2}{(1511.47 \times 10^3)^3} = \boxed{1.4 \times 10^{-16} \ d^2/Km^3}$$

Uranus

$$K = \frac{T^2}{r^3} = \frac{(1.414)^2}{(125.4 \times 10^3)^3} = \boxed{9.2 \times 10^{-16} \ d^2/Km^3}$$

⑥ Neptune

$$K = \frac{T^2}{r^3} = \frac{(5.877)^2}{(385.3\times10^3)^3} = \boxed{7.7\times10^{-16}\ d^2/Km^3}$$

Pluto

$$K = \frac{T^2}{r^3} = \frac{(6.387)^2}{(19.7\times10^3)^3} = \boxed{5.3\times10^{-12}\ d^2/Km^3}$$

⑦

$$\frac{T^2}{r^3} = \frac{T_m^2}{r_m^3}$$

$$\frac{T^2}{[2(6.38\times10^6)]^3} = \frac{(2.36\times10^6)^2}{(3.8\times10^8)^3}$$

$$T = \sqrt{\frac{[2(6.38\times10^6)]^3\cdot(2.36\times10^6)^2}{(3.8\times10^8)^3}}$$

$$T = 14\,521.538\ s$$

$\div 3600\ s/h$

$$T = \boxed{4.0\ h}$$

(8)

$$\frac{r_p^3}{T_p^2} = \frac{r_d^3}{T_d^2}$$

$$\frac{r_p^3}{(7.65)^2} = \frac{(2.3\times10^4)^3}{(30.3)^2}$$

$$r_p = \sqrt[3]{\frac{(7.65)^2 (2.3\times10^4)^3}{(30.3)^2}}$$

$$r_p = \boxed{9187.7 \text{ Km}}$$